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For: METHOD AND APPARATUS FOR SPEECH RECOGNITION

PERFECTION OF PRIORITY

Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

Enclosed is an English translation of Korean Patent Application No. 2002-87943, filed on December 31, 2002, which the present application claims priority from. A Certificate of Translation of this English translation of Korean Patent Application No. 2002-87943 is also enclosed.

Respectfully submitted,

STAAS & HALSEY LLP

By:

Stephen T. Boughner
Registration No. 45,317

Date: 12/23/08

1201 New York Avenue, N.W., 7th Floor
Washington, D.C. 20005
Telephone: (202) 434-1500
Facsimile: (202) 434-1501



CERTIFICATION OF TRANSLATION

I, Youngin Seo, an employee of Y.P. LEE, MOCK & PARTNERS of The Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Korean language and the English language; that I am fully capable of translating from Korean to English and vice versa; and that, to the best of my knowledge and belief, the statements in the English language in the attached translation of Method and apparatus for speech recognition (Korean Patent Application No. 10-2002-0087943 filed on 31 December 2002), consisting of 31 pages, have the same meanings as the statements in the Korean language in the original document, a copy of which I have examined.

Signed this 8th day of December, 2008

Youngin Seo

A handwritten signature in black ink, appearing to read "Youngin Seo". A horizontal line is drawn through the signature, and the name is repeated below it in a smaller, printed-style font.



A B S T R A C T

[Abstract of the Disclosure]

A method and apparatus for enhancing the performance of speech recognition by
5 adaptively changing a process of determining a final, recognized word depending on a user's selection in a list of alternative words represented by a result of speech recognition. A speech recognition method comprising: (a) recognizing speech uttered by a user and displaying a list of alternative words to list a predetermined number of recognition results in a predetermined order, (b) determining whether a user's selection 10 from the list of alternative words has been changed within a predetermined standby time, (c) if the user's selection has not been changed within the predetermined standby time, determining an alternative word from the list of the alternative words currently indicated by a cursor, as a final, recognized word, and (d) if the user's selection has been changed within the predetermined standby time, adjusting the standby time and 15 returning to operation (b).

[Representative Drawing]

FIG. 3

S P E C I F I C A T I O N

[Title of the Invention]

5 Method and apparatus for speech recognition

[Brief Description of the Drawings]

FIG. 1 is a block diagram of a speech recognition apparatus according to an embodiment of the present invention;

10 FIG. 2 is a detailed block diagram of a post-processor of FIG. 1;

FIG. 3 is a flowchart for explaining a process of updating an erroneous word pattern database (DB) by an erroneous word pattern manager of FIG. 2;

FIG. 4 is a table showing an example of the erroneous word pattern DB of FIG. 2;

15 FIG. 5 is a flowchart for explaining a process of changing the order of the arrangement of alternative words by the erroneous word pattern manager of FIG. 2;

FIG. 6 is a flowchart for explaining a process of adjusting a standby time by a dexterity manager of FIG. 2;

FIG. 7 is a flowchart for explaining a speech recognition method, according to an embodiment of the present invention;

20 FIG. 8 is a flowchart for explaining a speech recognition method, according to another embodiment of the present invention; and

FIG. 9 shows an example of a graphic user interface according to the present invention.

25 [Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art prior to the Invention]

30 The present invention relates to speech recognition, and more particularly, to a method and apparatus for enhancing the success rate of speech recognition tasks by adaptively changing a process of determining a final, recognized word depending on a user's selection in a list of alternative words represented by a result of speech recognition.

35 Speech recognition refers to a technique by which a computer analyzes and recognizes or understands human speech. Human speech sounds have specific frequencies according to the shape of a human mouth and positions of a human tongue

5 during utterance. In other words, in speech recognition technology, human speech sounds are converted into electric signals and frequency characteristics of the speech sounds are extracted from the electric signals, in order to recognize human utterances. Such speech recognition technology is adopted in a wide variety of fields such as telephone dialing, control of electronic toys, language learning, control of electric home appliances, and so forth.

10 Despite the advancement of speech recognition technology, speech recognition cannot yet be fully accomplished due to background noise or the like in an actual speech recognition environment. Thus, errors frequently occur in speech recognition tasks. In order to reduce the probability of the occurrence of such errors, there are employed methods of determining a final, recognized word depending on user confirmation or selection by requesting the user to confirm recognition results of a speech recognizer or by presenting the user with a list of alternative words derived from the recognition results of the speech recognizer.

15 Conventional techniques associated with the above methods are disclosed in U.S. Patent. Nos. 4,866,778, 5,027,406, 5,884,258, 6,314,397, 6,347,296, and so on. U.S. Patent. No. 4,866,778 suggests a technique by which the most effectively searched probable alternative word is displayed and if the probable alternative word is wrong, the next alternative word is displayed to find the correct recognition result.

20 According to this technique, a user must separately answer a series of YES/NO questions presented by a speech recognition system and cannot predict which words will appear in the next question, which results in its inefficiency. U.S. Patent. Nos. 5,027,406 and 5,884,258 present a technique by which alternative words derived from speech recognition are arrayed and recognition results are determined depending on 25 user's selections from the alternative words via a graphic user interface or voice.

According to this technique, since the user must perform additional manipulations to select the correct alternative word in each case after he or she speaks, he or she experiences inconvenience and is tired of the iterative operations. U.S. Patent. No. 6,314,397 shows a technique by which user's utterances are converted into texts based 30 on the best recognition results and corrected through a user review during which an alternative word is selected from a list of alternative words derived from previously considered recognition results. This technique suggests a smooth speech recognition task. However, when the user uses a speech recognition system in real time, the user must create a sentence, viewing recognition results. Accordingly, it is unreasonable to 35 input the erroneous recognition result as it is. U.S. Patent. No. 6,347,296 discloses a

technique by which during a series of speech recognition tasks, an indefinite recognition result of a specific utterance is settled by automatically selecting an alternative word from a list of alternative words with reference to a recognition result of a subsequent utterance. According to this technique, successive errors may be caused by either an indefinite recognition result of a subsequent utterance or an imperfect language model.

As described above, according to conventional speech recognition technology, although a correct recognition result of user speech is obtained, an additional task such as user confirmation or selection must be performed at least once. In addition, when the user confirmation is not performed, an unlimited amount of time is taken to determine a final, recognized word.

[Technical Goal of the Invention]

The present invention provides a speech recognition method of determining a first alternative word as a final, recognized word after a predetermined standby time in a case where a user does not select an alternative word from a list of alternative words derived from speech recognition of the user's utterance, determining a selected alternative word as a final, recognized word when the user selects the alternative word, or determining an alternative word selected after an adjusted standby time as a final, recognized word.

The present invention also provides an apparatus for performing the speech recognition method.

According to an aspect of the present invention, there is provided a speech recognition method comprising: (a) recognizing speech uttered by a user and displaying a list of alternative words to list a predetermined number of recognition results in a predetermined order, (b) determining whether a user's selection from the list of alternative words has been changed within a predetermined standby time, and (c) if the user's selection has not been changed within the predetermined standby time, determining an alternative word from the list of the alternative words currently indicated by a cursor, as a final, recognized word.

Preferably, the speech recognition method further comprises either (d) if the user's selection has been changed within the predetermined standby time, adjusting the standby time and returning to operation (b) or (d)) if the user's selection has been changed within the predetermined standby time, determining an alternative word selected by the user as a final, recognized word.

According to another aspect of the present invention, there is provided a speech recognition apparatus comprising: a speech input unit that inputs speech uttered by a user; a speech recognizer that recognizes the speech input from the speech input unit and creates a predetermined number of alternative words to be recognized in the order of similarity; and a post-processor that displays a list of alternative words that arranges the predetermined number of alternative words in a predetermined order and determines an alternative word that a cursor currently indicates as a final, recognized word if a user's selection from the list of alternative words has not been changed within a predetermined standby time.

Preferably, the post-processor comprises: a window generator that generates a window for a graphic user interface comprising the list of alternative words; a standby time setter that sets a standby time from when the window is displayed to when the alternative word on the list of alternative words currently indicated by the cursor is determined as the final, recognized word; and a final, recognized word determiner that determines a first alternative word from the list of alternative words that is currently indicated by the cursor as a final, recognized word if the user's selection from the list of alternative words has not been changed within the predetermined standby time, adjusts the predetermined standby time if the user's selection from the list of alternative words has been changed within the predetermined standby time, and determines an alternative word on the list of alternative words selected by the user as a final, recognized word if the user's selection has not been changed within the adjusted standby time.

Preferably, the post-processor comprises: a window generator that generates a window for a graphic user interface comprising a list of alternative words that arranges the predetermined number of alternative words in a predetermined order; a standby time setter that sets a standby time from when the window is displayed to when an alternative word on the list of alternative words currently indicated by the cursor is determined as a final, recognized word; and a final, recognized word determiner that determines a first alternative word on the list of alternative words currently indicated by the cursor as a final, recognized word if a user's selection from the list of alternative words has not been changed within the standby time and determines an alternative word on the list of alternative words selected by the user as a final, recognized word if the user's selection from the list of alternative words has been changed.

[Structure of the Invention]

Hereinafter, embodiments of the present invention will be described in detail with reference to the attached drawings.

FIG. 1 is a block diagram of a speech recognition apparatus according to an embodiment of the present invention. Referring to FIG. 1, the speech recognition apparatus includes a speech input unit 11, a speech recognizer 13, and a post-processor 15.

The speech input unit 11 includes microphones and so forth, receives speech from a user, removes a noise signal from the user speech, amplifies the user speech to a predetermined level, and transmits the user speech to the speech recognizer 13.

The speech recognizer 13 detects a starting point and an ending point of the user speech, samples speech feature data from sound sections except soundless sections before and after the user speech, and vector-quantizes the speech feature data in real-time. Next, the speech recognizer 13 performs a viterbi search to choose the closest acoustic word to the user speech from words stored in a DB using the speech feature data. To this end, Hidden Markov Models (HMMs) may be used. Feature data of HMMs, which are built by training words, is compared with that of currently input speech, so as to determine the most probable candidate word. The speech recognizer 13 completes the viterbi search, determines a predetermined number, for example, 3 of the closest acoustic words to currently input speech as recognition results in the order of similarity, and transmits the recognition results to the post-processor 15.

The post-processor 15 receives the recognition results from the speech recognizer 13, converts the recognition results into text signals, and creates a window for a graphic user interface. Here, the window displays the text signals in the order of similarity. An example of the window is shown in FIG. 9. As shown in FIG. 9, a window 91 includes a message area 92 for displaying a message "A first alternative word, herein, 'Tam Saek Gi', is being recognized", an area 93 for displaying a time belt, and an area 94 for displaying a list of alternative words. The window 91 is displayed on a screen until the time belt 93 corresponding to a predetermined standby time is over. In addition, in a case where there is no additional user input with an alternative word selection key or button within the standby time, the first alternative word is determined as a final, recognized word. On the contrary, when there is an additional user input with the alternative word selection key or button within the standby time, a final, recognized word is determined through a process shown in FIG. 7 or 8 which will be explained later.

FIG. 2 is a detailed block diagram of the post-processor 15 of FIG. 1. Referring to FIG. 2, the post-processor 15 includes a standby time setter 21, a dexterity manager 22, a dexterity DB 23, a window generator 24, an erroneous word pattern manager 25, an erroneous word pattern DB 26, and a final, recognized word determiner 27.

5 The standby time setter 21 sets a standby time from a point in time when the window 91 for the graphic user interface is displayed to a point in time when an alternative word currently indicated by a cursor is determined as a final, recognized word. The standby time is represented by the time belt 93 in the window 91. The standby time may be equally assigned to all of the alternative words on the list of
10 alternative words. The standby time may also be assigned differentially to each of the alternative words from the most acoustically similar alternative word to the least acoustically similar alternative word. The standby time may be equally assigned to users or may be assigned differentially to the user depending on the user's dexterity. The standby time setter 21 provides the window generator 24 with the standby time and
15 the recognition results input from the speech recognizer 13.

The dexterity manager 22 adds a predetermined spare time to a selection time determined based on information on a user's dexterity stored in the dexterity DB 23, adjusts the standby time to the addition value, and provides the standby time setter 21 with the adjusted standby time. Here, the dexterity manager 22 adjusts the standby time through a process shown FIG. 6 which will be explained later. In addition, the standby time may be equally assigned to all of the alternative words or may be assigned differentially to each of the alternative words from the most acoustically similar alternative word to the least acoustically similar alternative word.

25 The dexterity DB 23 stores different selection times determined based on the user's dexterity. Here, 'dexterity' is a variable in inverse proportion to a selection time required for determining a final, recognized word after the window for the graphic user interface is displayed. In other words, an average value of selection times required for a predetermined number of times a final, recognized word is determined is determined as the user's dexterity.

30 The window generator 24 generates the window 91 including the message area 92, the time belt 93, and the alternative word list 94 as shown in FIG. 9. The message area 92 displays a current situation, the time belt 93 corresponds to the standby time set by the standby time setter 21, and the alternative word list 94 lists the recognition results, i.e., the alternative words, in the order of similarity. Here, the order of listing

the alternative words may be determined based on erroneous word patterns appearing in previous speech recognition history as well as the similarity.

The erroneous word pattern manager 25 receives a recognized word determined as the first alternative word by the speech recognizer 13 and the final, recognized word provided by the final, recognized word determiner 27. If the erroneous word pattern DB 26 stores the combination of the recognized words corresponding to the first alternative word and the final, recognized word, the erroneous word pattern manager 25 adjusts the recognition results supplied from the speech recognizer 13 to the window generator 24 and matching scores, so as to be provided to the window generator 24.

- 5 The window generator 24 then changes the listing order of the alternative word list 94 based on the adjusted matching scores. For example, if "U hui-jin" is determined as the first alternative word and "U ri jib" is determined as the final, recognized word, predetermined weight is laid on "U ri jib". As a result, although the speech recognizer 13 determines "U hui jin" as the first alternative word, the window generator 24 can 10 array "U ri jib" in a higher position than "U hui jin".
- 15

When the first alternative word and the final, recognized word are different, the erroneous word pattern DB 26 stores the first alternative word and the final, recognized word as erroneous word patterns. As shown in FIG. 4, an erroneous word pattern table includes a first alternative word 41 resulting from speech recognition, a final, 20 recognized word 42, first through n^{th} user utterance features 43, an utterance propensity 43, and a number of times errors occur, i.e., a history n 45.

- 25 The final, recognized word determiner 27 determines the alternative word currently indicated by the cursor as the final, recognized word depending on whether the user makes an additional selection from the alternative word list 94 in the window 91 within the standby time represented by the time belt 93. In other words, when the user does not additionally press the alternative word selection key or button within the standby time after the window 91 is displayed, the final, recognized word determiner 27 determines the first alternative word currently indicated by the cursor as the final, 30 recognized word. When the user presses the alternative word selection key or button within the standby time, the final, recognized word determiner 27 determines the final, recognized word through the process of FIG. 7 or 8.

35 FIG. 3 is a flowchart for explaining a process of updating the erroneous word pattern DB 26 by the erroneous word pattern manager 25 of FIG. 2. Referring to FIG. 3, in step 31, a determination is made as to whether the erroneous word pattern DB 26 stores a pair of the first alternative word and the final, recognized word provided by the

final, recognized word determiner 27. If in step 301, it is determined that the erroneous word pattern DB 26 does not store the pair of the first alternative word and the final, recognized word, the process ends.

If in step 31, it is determined that the erroneous word pattern DB 26 stores the 5 pair of the first alternative word and the final, recognized word, in step 32, a difference value in utterance features is calculated. The difference value is a value obtained by adding absolute values of differences between the first through n^{th} utterance features 43 of the erroneous word patterns stored in the erroneous word pattern DB 26 and first through n^{th} utterance features of currently input speech.

In step 33, the difference value is compared with a first threshold for update. If 10 in step 33, it is determined that the difference value is greater than or equal to the first threshold, the process ends. If in step 33, the difference value is less than the first threshold, i.e., if it is determined that an error occurs for the same reason for the previous error such as a cold, voice change in the mornings, background noise, or the 15 like as the erroneous word pattern, in step 34, it is determined whether the first alternative word is equal to the corresponding final, recognized word. The first threshold may be set to an optimum value experimentally or through a simulation.

In step 35, an average value of the first through n^{th} utterance features of currently 20 input speech is calculated to update an utterance propensity 44 and in step 36, a value of a history of a corresponding erroneous word pattern increases by 1 to update the 25 history 45, if the first alternative word is different from the corresponding final, recognized word according to the result of determination in step 34.

In step 37, it is determined whether a value of a history n is greater than 0 if the first alternative word is equal to the final, recognized word according to the result of 30 determination in step 34. If it is determined that the value of the history n is smaller than or equals to 0, the process ends. In step 38, the value of the history n decreases by 1 to update the history 45, if it is determined that the value of the history n is greater than 0 according to the result of determination in step 37.

FIG. 5 is a flowchart for explaining a process of changing an order of listing 35 alternative words via the erroneous word pattern manager 25 of FIG. 2.

Referring to FIG. 5, in step 51, a determination is made as to whether the erroneous word pattern DB 26 stores a pair of a first alternative word and a second alternative word as the final, recognized word or a pair of a first alternative word and a third alternative word as the final, recognized word, with reference to the recognition 35 results and matching scores of Table 1 provided to the window generator 24 via the

speech recognizer 13. If in step 51, it is determined that the erroneous word pattern DB 26 does not store the pair of the first alternative word and the second alternative word or the pair of the first alternative word and the third alternative word, the process ends. Here, Table 1 shows scores of a first to a third alternate words.

5

[Table 1]

| Recognition Result | Matching Scores |
|--------------------|-----------------|
| Hwang Gil Du | 10 |
| Hong Gi Su | 9 |
| Hong Gil Dong | 8 |

If in step 51, it is determined that the erroneous word pattern DB 26 stores the first alternative word, the second alternative word and the third alternative word, in step 10 52, a difference value in first through n^{th} utterance features are calculated. As described with reference to FIG. 3, the difference value is a value obtained by adding absolute values of differences between the first through n^{th} utterance features stored in the erroneous word pattern DB 26 and first through n^{th} utterance features of currently input speech.

In step 53, the difference value is compared with a second threshold for changing the order of listing the alternative words. If in step 53, it is determined that the difference value in each pair is greater than or equal to the second threshold, i.e., an error does not occur for the same reason as the previous error, the process ends. The second threshold may be set to an optimum value experimentally or through a simulation. If in step 53, it is determined that the difference value in each pair is less than the second threshold, i.e., the error occurs for the same reason as the previous error, in step 54, a matching score of a corresponding alternative word is adjusted. For example, in a case where the erroneous word pattern DB 26 stores an erroneous word pattern table as shown in FIG. 4 and the weight is set to 0.4, the recognition results and the matching scores shown in Table 1 are changed into recognition results and scores shown in Table 2. Here, a changed matching score "9.2" is obtained by adding a value resulting from multiplication of the weight "0.4" by a history "3" to an original matching score "8".

30 [Table 2]

| Recognition Result | Matching Score |
|--------------------|----------------|
|--------------------|----------------|

| | |
|---------------|-----|
| Hwang Gil Du | 10 |
| Hong Gi Su | 9.2 |
| Hong Gil Dong | 9 |

Meanwhile, the first through n^{th} utterance features 43 used in the processes shown in FIGS. 3 through 5 are information generated when the speech recognizer 13 analyzes speech. In other words, the information may be information, a portion of 5 which is used for determining speech recognition results and a remaining portion of which is used only as reference data. The information may also be measured using additional methods as follows.

First, a time required for uttering a corresponding number of syllables is defined as an utterance speed. Next, a voice tone is defined. When the voice tone is 10 excessively lower or higher than a microphone volume set in hardware, the voice tone may be the cause of an error. For example, a low-pitched voice is hidden by noise and a high-pitched voice is not partially received by hardware. As a result, a voice signal 15 may be distorted. Third, a basic noise level, which is measured in a state when no voice signal is input or in a space between syllables, is defined as a signal-to-noise ratio (SNR). Finally, the change of voice is defined in a specific situation where a portion of 20 voice varies due to cold or a problem with the vocal chords that occurs in the mornings. In addition, various other utterance features may be used.

FIG. 6 is a flowchart for explaining a process of adjusting the standby time via the dexterity manager 22 of FIG. 2.

Referring to FIG. 6, in step 61, a difference value in a selection time is calculated 25 by subtracting a time required for determining a final, recognized word from the selection time assigned for each user and stored in the dexterity DB 23.

In step 62, the difference value is compared with a third threshold for changing the standby time. If in step 62, it is determined that the difference value is greater than 30 the third threshold, i.e., a given time is longer than a time for which the user can determine a selection, in step 63, the selection time is modified. The third threshold may be set to an optimum value experimentally or through a simulation. The modified selection time is calculated by subtracting a value resulting from multiplication of the difference value by the predetermined weight from the selection time stored in the dexterity DB 23. For example, when the selection time stored in the dexterity DB 23 is 0.8 seconds, the difference value is 0.1 seconds, and the predetermined weight is 0.1,

the modified selection time is 0.79 seconds. The modified selection time is stored in the dexterity DB 23 so as to update a selection time for the user.

If in step 62, it is determined that the difference value is less than or equal to the third threshold, i.e., a final user's selection is determined by a timeout of the speech recognition system after the selection time ends, in step 64, the difference value is compared with a predetermined spare time. If in step 64, it is determined that the difference value is greater than or equal to the spare time, the process ends.

If in step 64, it is determined that the difference value is less than the spare time, in step 65, the selection time is modified. The modified selection time is calculated by adding a predetermined extra time to the selection time stored in the dexterity DB 23.

For example, when the selection time stored in the dexterity DB 23 is 0.8 seconds and the extra time is 0.02 seconds, the modified selection time is 0.82 seconds. The modified selection time is stored in the dexterity DB 23 so as to update a selection time for a user. The extra time is to prevent a potential error from occurring in a subsequent speech recognition process, and herein, is set to 0.02 seconds.

In step 66, a standby time for the user is calculated by adding a predetermined amount of extra time to the selection time modified in step 63 or 65, and the standby time setter 21 is informed of the calculated standby time. Here, the extra time is to prevent a user's selection from being determined regardless of the user's intension, and herein, is set to 0.3 seconds.

FIG. 7 is a flowchart for explaining a speech recognition method, according to an embodiment of the present invention. The speech recognition method includes step 71 of displaying a list of alternative words, steps of 72, 73, and 78 performed in a case of no change in a user's selection, and steps 74, 75, 76, and 77 performed in a case where a user's selection changes.

Referring to FIG. 7, in step 71, the window 91 including the alternative word list 94 listing the recognition results of the speech recognizer 13 is displayed. In the present invention, the cursor is set to indicate the first alternative word on the alternative word list 94 when the window 91 is displayed. In addition, the time belt 93 starts from 30 when the window 91 is displayed. In step 72, a determination is made as to whether an initial standby time set by the standby time setter 21 has elapsed without additional user input with the alternative word selection key or button.

If in step 72, it is determined that the initial standby time has elapsed, in step 73, a first alternative word currently indicated by the cursor is determined as a final, 35 recognized word. In step 78, a function corresponding to the final, recognized words is

performed. If in step 72, it is determined that the initial standby time has not elapsed, in step 74, a determination is made as to whether a user's selection has been changed by the additional user input with the alternative word selection key or button.

If in step 74, it is determined that the user's selection has been changed, in step 5 75, the initial standby time is reset. Here, the adjusted standby time may be equal to or different from the initial standby time according to an order of listing the alternative words. If in step 74, it is determined that the user's selection has not been changed, the process moves on to step 76. For example, if the user's selection is changed into 'Tan Seong Ju Gi' shown in FIG. 9, the message area 92 of the window 91 shows a 10 message "The 'Tan Seong Ju Gi' is being recognized" and concurrently, the time belt 93 starts according to the adjusted standby time.

In step 76, a determination is made as to whether the standby time adjusted in step 15 75 or the initial standby time has elapsed. If in step 76, it is determined that the adjusted standby time or the initial standby time has not elapsed, the process returns to step 74 to iteratively determine whether the user's selection has been changed. If in step 76, it is determined that the adjusted standby time or the initial standby time has elapsed, in step 77, an alternative word that the cursor currently indicates from a change in the user's selection is determined as a final, recognized word. In step 78, a function corresponding to the final, recognized word is performed.

FIG. 8 is a flowchart for explaining a speech recognition method, according to 20 another embodiment of the present invention. The speech recognition method includes step 81 of displaying a list of alternative words, steps 82, 83, and 86 performed in a case where there is no change in a user's selection, and steps 84, 85, and 86 performed in a case where there is a change in a user's selection.

Referring to FIG. 8, in step 81, the window 91 including the alternative word list 25 94 listing the recognition results of the speech recognizer 13 is displayed. The time belt 93 starts from when the window 91 is displayed. In step 82, a determination is made as to whether an initial standby time set by the standby time setter 21 has elapsed without an additional user input via the alternative word selection key or button.

If in step 82, it is determined that the initial standby time has elapsed, in step 30 83, a first alternative word currently indicated by the cursor is determined as a final, recognized word. In step 86, a function corresponding to the final, recognized word is performed. If in step 82, it is determined that the initial standby time has not elapsed, in step 84, a determination is made as to whether a user's selection has been changed 35 by the additional user input via the alternative word key or button. If in step 84, it is

determined that the user's selection has been changed, in step 85, an alternative word that the cursor currently indicates due to the change in the user's selection is determined as the final, recognized word. In step 86, a function corresponding to the final, recognized word is performed. If in step 84, it is determined that the user's

- 5 selection has not been changed, the process returns to step 82.

Table 3 below shows comparisons of existing speech recognition methods and a speech recognition method of the present invention, in respect to success rates of speech recognition tasks and a number of times an additional task is performed in various recognition environments.

10

[Table 3]

| Suggestion Method of Alternative Word | 90% Recognition Environment | | | | 70% Recognition Environment | | | |
|---------------------------------------|-----------------------------|----------------------------|----------------------------|-------|-----------------------------|----------------------------|----------------------------|-------|
| | Additi-onal Task 0 Time | Additi-onal Task 1 Time | Additi-onal Task 2 Time | Total | Additi-onal Task 0 Time | Additi-onal Task 1 Time | Additi-onal Task 2 Time | Total |
| Existing method 1 | 90% | 0% | 0% | 90% | 70% | 0% | 0% | 70% |
| Existing method 2 | 0% | 90% | 0% | 90% | 0% | 70% | 0% | 70% |
| Existing method 3 | 0% | 99.9% | 0% | 99.9% | 0% | 97.3% | 0% | 97.3% |
| Present Invention | 90% | 9% | 0.9% | 99.9% | 70% | 21% | 6.3% | 97.3% |

Alternative words are suggested in existing method 1. In existing method 2, a user determines the best alternative word. In existing method 3, a user selects an

- 15 alternative word from a list of alternative words corresponding to recognition results.

Also, data shown in Table 1 was obtained on the assumption that 90% recognition environment refers to noise in an office, 70% recognition environment refers to noise where a car travels on a highway, and a list of alternative words to be recognized is infinite, the alternative words on the list of alternative words are similar. According to

- 20 Table 1, when the speech recognition method of the present invention is adopted, as the additional task is iteratively performed, the success rate of the speech recognition task is maximized.

The present invention can be realized as a computer-readable code on a computer-readable recording medium. For example, a speech recognition method can be accomplished as first and second programs to be recorded on a computer-readable recording medium. The first program includes the following tasks of: recognizing
5 speech uttered by a user and displaying a list of alternative words to list a predetermined number of recognition results in a predetermined order. The second program includes the following tasks of: determining whether a user's selection from the list of alternative words has been changed within a predetermined standby time; if the user's selection has not been changed within the predetermined standby time,
10 determining an alternative word from the list of the alternative words currently indicated by a cursor, as a final, recognized word; if the user's selection has been changed within the predetermined standby time, the standby time is adjusted; iteratively determining whether the user's selection has been changed within the adjusted standby time; and if the user's selection has not been changed within the adjusted standby time,
15 determining an alternative word selected by the user as a final, recognized word. Here, the second program may be replaced with a program including the following tasks of: determining whether a user's selection from a list of alternative words has been changed within a predetermined standby time; if the user's selection has not been changed within the predetermined standby time, determining an alternative word from
20 the list of alternative words currently indicated by a cursor, as a final, recognized word; and if the user's selection has been changed within the predetermined standby time, determining an alternative word selected by the user as a final, recognized word.

A computer-readable medium may be any kind of recording medium in which computer-readable data is stored. Examples of such computer-readable media include
25 ROMs, RAMs, CD-ROMs, magnetic tapes, floppy discs, optical data storing devices, and carrier waves (e.g., transmission via the Internet), and so forth. Also, the computer-readable code can be stored on the computer-readable media distributed in computers connected via a network.

Furthermore, functional programs, codes, and code segments for realizing the
30 present invention can be easily analogized by programmers skilled in the art.

Moreover, a speech recognition method and apparatus according to the present invention can be applied to various platforms of personal mobile communication devices such as personal computers, portable phones, personal digital assistants (PDA), and so forth. As a result, success rates of speech recognition tasks can be improved.

[Effect of the Invention]

As described above, in a speech recognition method and apparatus according to the present invention, a number of times a user performs an additional task and psychological pressure put on the user can be minimized, even in a poor speech recognition environment, and a final success rate of speech recognition performed via a voice command can be maximized. As a result, efficiency of speech recognition can be improved.

In addition, when a user's selection is not changed within a predetermined standby time, a subsequent task can be automatically performed. Thus, a number of times the user manipulates a button for speech recognition can be minimized. As a result, since the user can easily perform speech recognition, user satisfaction of a speech recognition system can be increased. Moreover, a standby time can be adaptively adjusted to a user. Thus, a speed for performing speech recognition tasks can be reduced.

While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

What is claimed is:

1. A speech recognition method comprising:

(a) recognizing speech uttered by a user and displaying a list of alternative words

5 to list a predetermined number of recognition results in a predetermined order;

(b) determining whether a user's selection from the list of alternative words has been changed within a predetermined standby time; and

(c) if the user's selection has not been changed within the predetermined standby time, determining an alternative word from the list of the alternative words currently

10 indicated by a cursor, as a final, recognized word.

2. The speech recognition method of claim 1, further comprising:

(d) if the user's selection has been changed within the predetermined standby time, adjusting the standby time and returning to operation (b)

15 3. The speech recognition method of claim 1, further comprising:

(d) if the user's selection has been changed within the predetermined standby time, determining an alternative word selected by the user as a final, recognized word.

20 4. The speech recognition method of any one of claims 1 through 3, wherein operation (a) comprises adjusting the predetermined order of listing the alternative words using a matching score of the speech uttered by the user and erroneous word patterns appeared in a history of speech recognition..

25 5. The speech recognition method of claim 4, wherein operation (a) comprises:

(a1) calculating a difference value in utterance features if a predetermined erroneous word pattern database stores a first alternative word resulting from the recognition of the speech;

30 (a2) comparing the difference value obtained in operation (a1) with a first threshold;

(a3) determining whether the first alternative word is equal to the final, recognized word if the difference value is smaller than the first threshold according to the result of comparison in operation (a2);

(a4) calculating an average value of the utterance features of currently input speech to update an utterance propensity and increasing a value of a history of a corresponding erroneous word pattern by 1 to update the history, if the first alternative word is different from the final, recognized word according to the result of determination

5 in operation (a3); and

(a5) decreasing the value of the history of the corresponding erroneous word pattern by 1 to update the history, if the first alternative word is equal to the final, recognized word according to the result of determination in operation (a3) and the value of the history of the corresponding erroneous word pattern is greater than 1.

10

6. The speech recognition method of claim 4, wherein operation (a) comprises:

(a1) calculating a difference value in utterance features if a predetermined erroneous word pattern database stores at least one of a pair of first and second alternative words and a pair of first and third alternative words derived from the recognition of the speech;

(a2) comparing the difference value obtained in operation (a1) with a second threshold; and

(a3) modifying a matching score of a corresponding alternative word if the difference value is smaller than the second threshold according to the result of comparison in operation (a2).

7. The speech recognition method of claim 6, wherein the modified matching score in operation (a3) is calculated by adding a value resulting from multiplication of an original matching score by a history value of the corresponding alternative word by a predetermined weight.

8. The speech recognition method of any one of claims 1 through 3, further comprising (d) adjusting the standby time according to user dexterity before operation 30 (b).

9. The speech recognition method of claim 8, wherein operation (d) comprises:

(d1) calculating a difference value in a selection time by subtracting a time for determining a final, recognized word from a selection time assigned for each user and stored in a dexterity database;

(d2) comparing the difference value in the selection time obtained in operation

5 (d1) with a third threshold;

(d3) modifying the selection time if the difference value in the selection time is greater than the third threshold, according to the result of comparison in operation (d2);

(d4) comparing the difference value in the selection time with a predetermined spare time if the difference value in the selection time is less than or equal to the third
10 threshold, according to the result of comparison in operation (d2);

(d5) modifying the selection time if the difference value in the selection time is less than the spare time according to the result of comparison in operation (d4); and

(d6) calculating a standby time of a corresponding user by adding a predetermined extra time to the modified selection time in operation (d3) or (d5).

15

10. The speech recognition method of claim 9, wherein in operation (d3), the selection time is modified by subtracting a value resulting from multiplication of the difference value in the selection time by a predetermined weight from the selection time stored in the dexterity database.

20

11. The speech recognition method of claim 9, wherein in operation (d5), the selection time is modified by adding a predetermined extra time to the selection time stored in the dexterity database.

25

12. The speech recognition method of any one of claims 1 through 3, wherein the standby time is equally assigned to all of the alternative words on the list of alternative words.

30

13. The speech recognition method of any one of claims 1 through 3, wherein the standby time is assigned differentially to each of the alternative words on the list of alternative words according to the predetermined order of listing the alternative words.

14. A computer-readable recording medium comprising:

a first program that recognizes speech uttered by a user and displays a list of alternative words to list a predetermined number of alternative words derived from the recognition of the speech in a predetermined order; and

5 a second program that determines whether a user's selection from the list of alternative words has been changed within a predetermined standby time and determines an alternative word on the list of alternative words that a cursor currently indicates, as a final, recognized words, if the user's selection has not been changed.

10 15. The computer-readable recording medium of claim 14, wherein the second program further comprises:

adjusting the standby time if the user's selection has been changed within the predetermined standby time;

determining whether the user's selection has been changed within the adjusted standby time; and

15 determining an alternative word on the list of alternative words selected by the user as a final, recognized word if it is determined that the user's selection has not been changed within the adjusted standby time.

20 16. The computer-readable recording medium of claim 14, wherein the second program further comprises:

determining an alternative word on the list of alternative words selected by the user as a final, recognized word if it is determined that the user's selection has been changed within the predetermined standby time.

25 17. A speech recognition apparatus comprising:

a speech input unit that inputs speech uttered by a user;

a speech recognizer that recognizes the speech input from the speech input unit using a predetermine speech recognition algorithm and creates a predetermined number of alternative words to be recognized in the order of similarity; and

30 a post-processor that displays a list of alternative words that arranges the predetermined number of alternative words in a predetermined order and determines an alternative word that a cursor currently indicates as a final, recognized word if a user's selection from the list of alternative words has not been changed within a predetermined standby time.

18. The speech recognition apparatus of claim 17, wherein the post-processor comprises:

a window generator that generates a window for a graphic user interface comprising the list of alternative words;

5 a standby time setter that sets a standby time from when the window is displayed to when the alternative word on the list of alternative words currently indicated by the cursor is determined as the final, recognized word; and

10 a final, recognized word determiner that determines a first alternative word from the list of alternative words that is currently indicated by the cursor as a final, recognized word if the user's selection from the list of alternative words has not been changed within the predetermined standby time, adjusts the predetermined standby time if the user's selection from the list of alternative words has been changed within the predetermined standby time, and determines an alternative word on the list of alternative words selected by the user as a final, recognized word if the user's selection 15 has not been changed within the adjusted standby time.

19. The speech recognition apparatus of claim 17, wherein the post-processor comprises:

20 a window generator that generates a window for a graphic user interface comprising a list of alternative words that arranges the predetermined number of alternative words in a predetermined order;

a standby time setter that sets a standby time from when the window is displayed to when an alternative word on the list of alternative words currently indicated by the cursor is determined as a final, recognized word; and

25 a final, recognized word determiner that determines a first alternative word on the list of alternative words currently indicated by the cursor as a final, recognized word if a user's selection from the list of alternative words has not been changed within the standby time and determines an alternative word on the list of alternative words selected by the user as a final, recognized word if the user's selection from the list of 30 alternative words has been changed.

20. The speech recognition apparatus of claim 18 or 19, wherein the post-processor further comprises:

35 an erroneous word pattern database that turns a recognized word determined as a first alternative word by the speech recognizer, a final, recognized word provided by

the final, recognized word determiner, at least one user utterance feature, a utterance propensity, and a history into data; and

5 an erroneous word pattern manager that receives recognition results and scores from the speech recognizer, adjusts a score of a recognized word corresponding to an erroneous word pattern, and informs the window generator of the adjusted score so as to change the order of listing the alternative words.

21. The speech recognition apparatus of claim 18 or 19, wherein the post-processor further comprises:

10 a dexterity database that turns a selection time on the user's dexterity into data; and

a dexterity manager that adjusts the standby time to a value obtained by adding a predetermined spare time to the selection time stored in the dexterity database and informs the standby time setter of the adjusted standby time.

15 22. The speech recognition apparatus of claim 20, wherein the post-processor further comprises:

a dexterity database that turns a selection time on the user's dexterity into data; and

20 a dexterity manager that adjusts the standby time to a value obtained by adding a predetermined spare time to the selection time stored in the dexterity database and informs the standby time setter of the adjusted standby time.

25 23. The speech recognition apparatus of claim 18 or 19, wherein the standby time is determined depending on the dexterity of the user.

24. The speech recognition apparatus of claim 18, wherein the adjusted standby time is equally assigned to all of the alternative words on the list of alternative words.

30 25. The speech recognition apparatus of claim 18, wherein the adjusted standby time is assigned differentially to each the alternative words on the list of alternative words according to an order of listing the alternative words on the list of alternative words.

FIG. 1

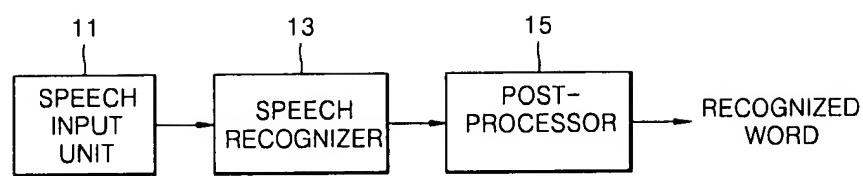


FIG. 2

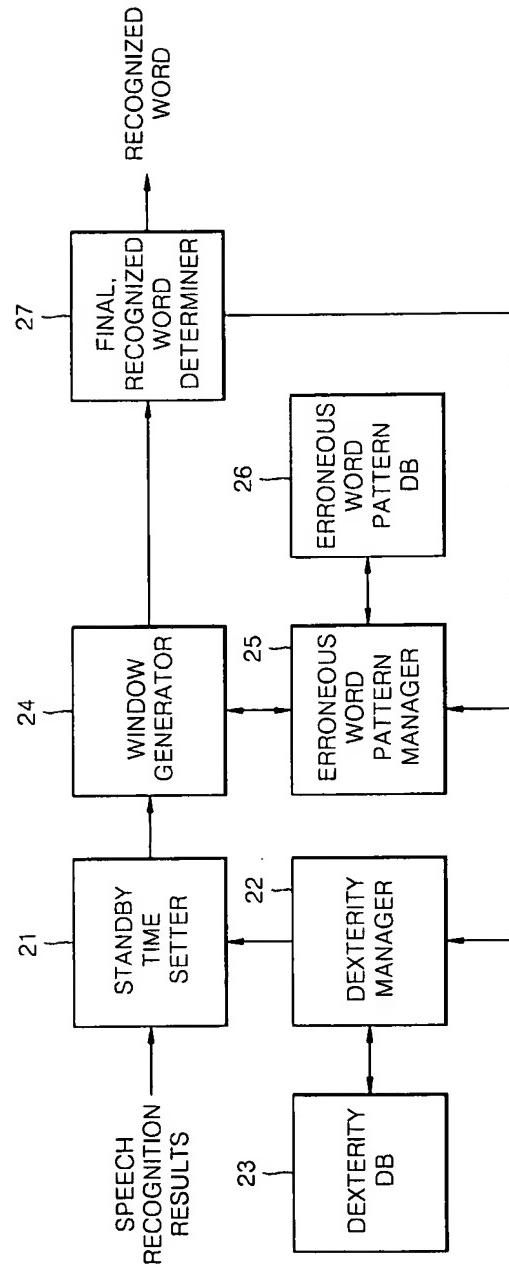


FIG. 3

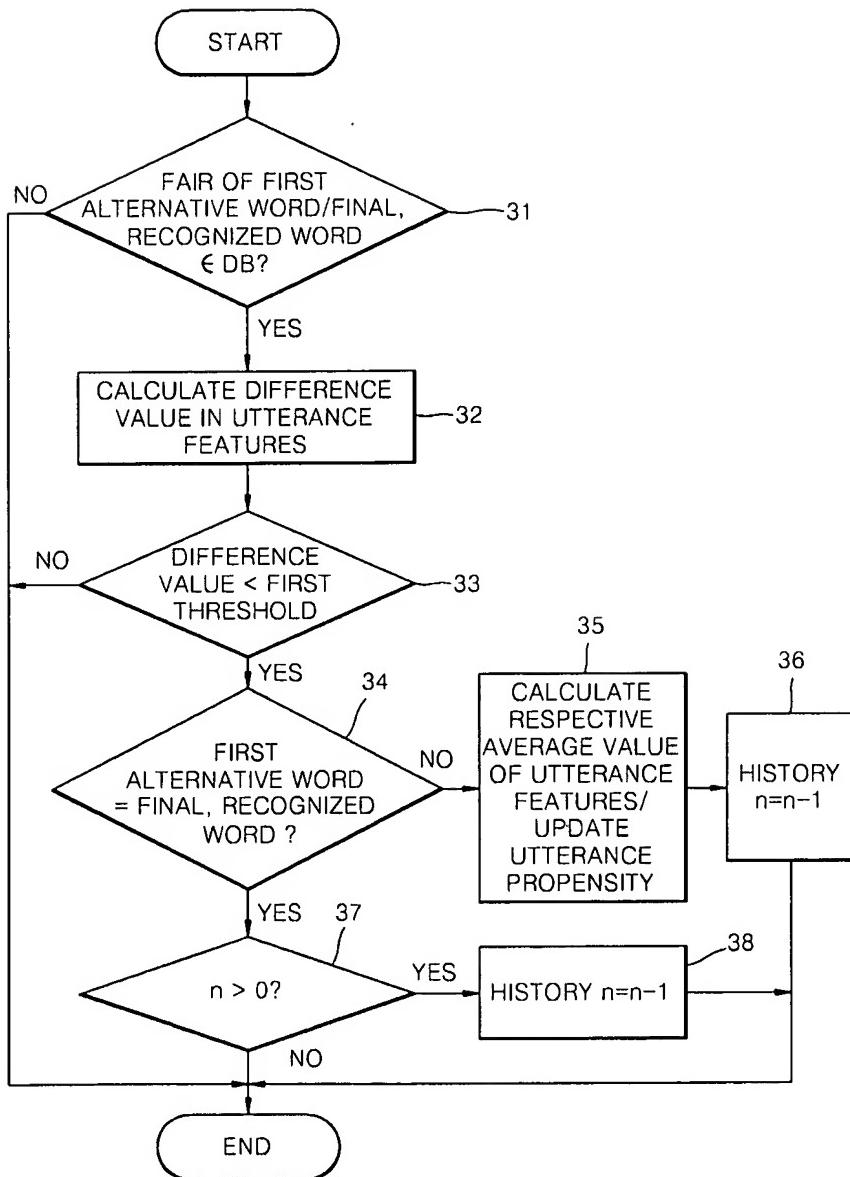


FIG. 4

| | | | | | | | | |
|--------------|--|------------------------|-------------------------|-----|-----------------------------------|----------------------|----------------|--|
| | | | | | | | | |
| 41 | FIRST ALTERNATIVE WORD RESULTING FROM SPEECH RECOGNITION | FINAL, RECOGNIZED WORD | FIRST UTTERANCE FEATURE | ... | n^{th} UTTERANCE FEATURE | UTTERANCE PROPENSITY | HISTORY(n) | |
| HWANG GIL DU | HONG GIL DONG | XX | XX | XX | XX | XX | 3 | |
| | | | | | | | | |

FIG. 5

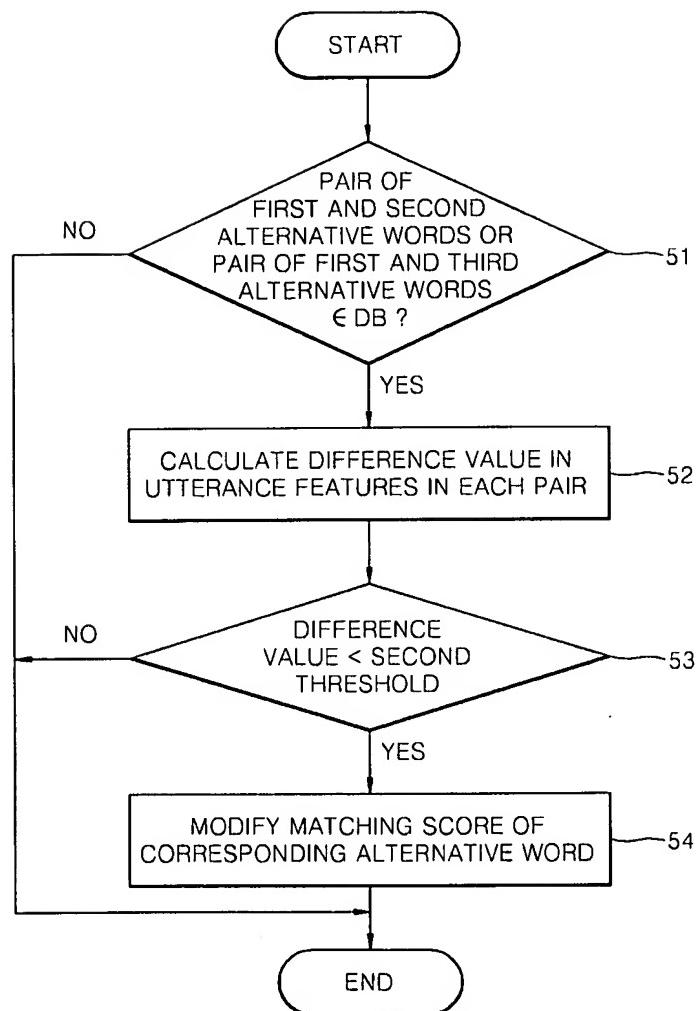


FIG. 6

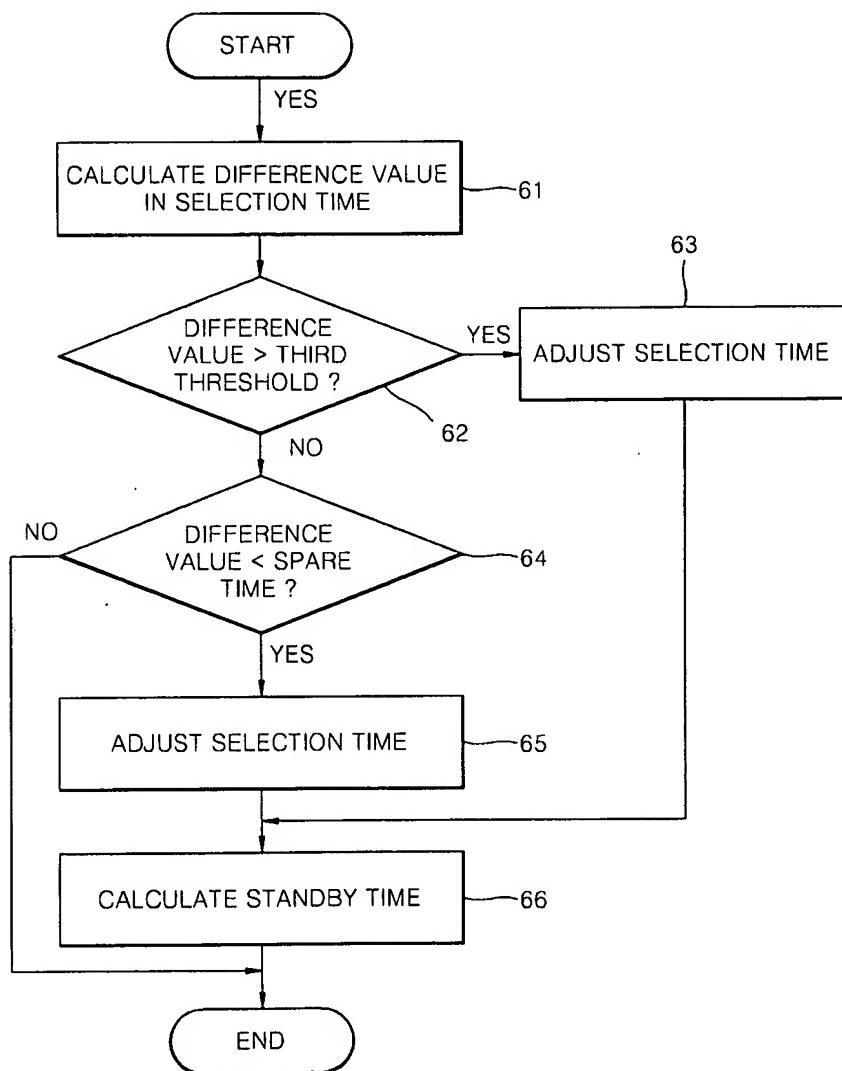


FIG. 7

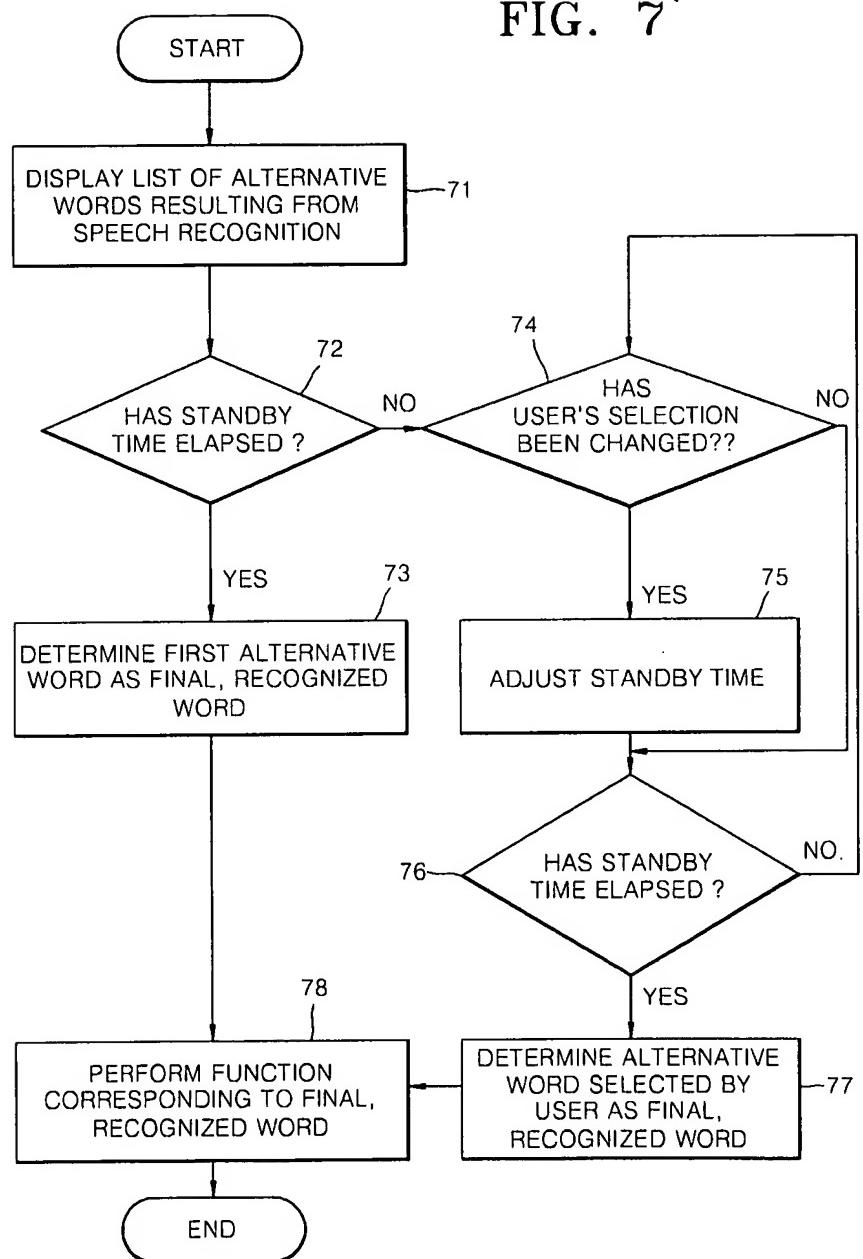


FIG. 8

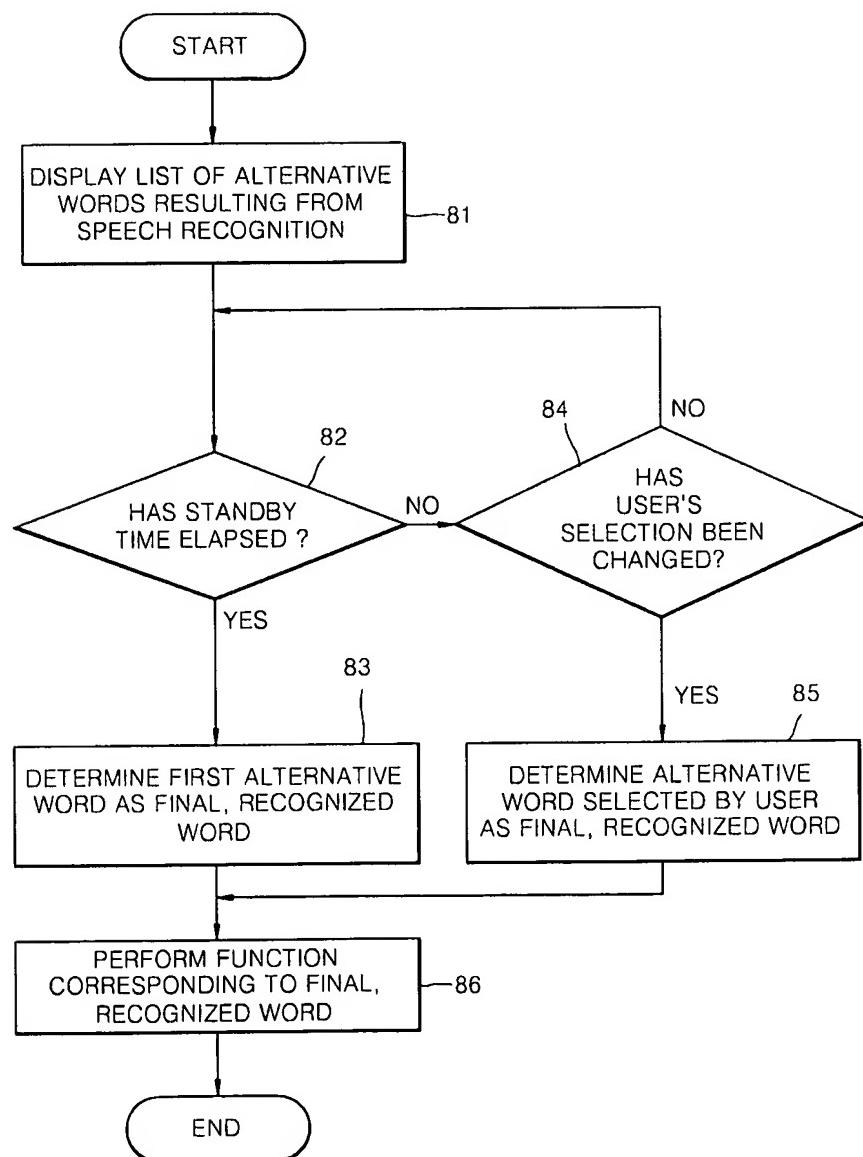


FIG. 9

